

WHAT IS CLAIMED IS:

1. An image processing method of creating
composite image information by embedding
sub-information in main image information, comprising:

5 performing, for the main image information, first
pre-processing corresponding to pixel formation
processing for image recording;

performing second pre-processing as geometric
transformation processing for the main image
10 information having undergone the first pre-processing;

performing embedding processing of creating
composite image information by embedding
sub-information in the main image information; and

15 performing transformation processing inverse to
the transformation processing in the second
pre-processing for the composite image information
created by the embedding processing.

2. An image processing method of recording, on a
recording medium in a visible state, composite image
20 information created by embedding sub-information in
visible main image information in an invisible state,
comprising:

performing, for the main image information, first
pre-processing corresponding to pixel formation
25 processing for image recording;

performing second pre-processing as geometric
transformation processing for the main image

information having undergone the first pre-processing;

performing embedding processing of creating
composite image information by embedding
sub-information in the main image information having
undergone the second pre-processing in an invisible
state;

performing transformation processing inverse to
the transformation processing in the second
pre-processing for the composite image information
created by the embedding processing; and

recording, on a recording medium, the composite
image information, inversely transformed by the inverse
transformation processing, by performing an alternate
driving/recording scheme of alternately recording
even-numbered and odd-numbered pixels in a main
scanning direction of a recording device on a recording
line basis.

3. A method according to claim 2, wherein in the
embedding processing, sub-information is embedded in
main image information in an invisible state by
performing color difference modulation processing using
a preset, predetermined color difference amount.

4. A method according to claim 2, wherein in the
embedding processing, the preset color difference
amount is corrected in accordance with each pixel
information of the main image information on a pixel
basis, and sub-information is embedded in the main

image information in an invisible state by performing color difference modulation processing by using the corrected color difference amount.

5 5. A method according to claim 2, wherein in the embedding processing, a processing of compressing a distribution of pixel luminance values of the main image information into a predetermined range is performed before embedding of the sub-information.

10 6. A method according to claim 5, wherein the processing of compressing the distribution of the pixel luminance values of the main image information comprises processing of omitting values not less than an upper limit value of a color plane of each pixel and not more than a lower limit value thereof.

15 7. A method according to claim 5, wherein the processing of compressing the distribution of the pixel luminance values of the main image information comprises processing of omitting values not less than an upper limit value of a color plane of each pixel and
20 not more than a lower limit value thereof, and processing of correcting a tone curve after the omitting processing into a straight line.

 8. A method according to claim 2, wherein in the embedding processing, a distribution of pixel luminance
25 values of the main image information before embedding of the sub-information into a predetermined range, the sub-information is embedded in the main image

information having undergone the compression processing, and processing inverse to the compression processing is performed.

5 9. A method according to claim 2, wherein in the embedding processing, color difference modulation processing is performed by using the main image information, the sub-information, and key information used to restore the sub-information, thereby creating composite image information.

10 10. A method according to claim 9, in which the key information is constituted by a geometric pattern having a predetermined specific frequency component, and

 which further comprises
15 optically reading the composite image information from a recording object on which the composite image information is recorded, and

 restoring the sub-information from the composite image information by performing filter processing for
20 the optically read composite image information using a frequency filter using a specific frequency component of the key information.

 11. A method according to claim 9, wherein the key information is constituted by a geometric
25 pattern having a predetermined specific frequency component, and

 in the first pre-processing, after processing of

removing a frequency component identical to the
specific frequency component of the key information
from the main image information or weakening the
frequency component, processing corresponding to the
5 pixel forming processing at the time of image recording
is performed for the main image information.

12. A method according to claim 9, wherein
the key information is constituted by a geometric
pattern having a predetermined specific frequency
10 component and includes a plurality of pieces of key
information, and

in the embedding processing, frequency component
analysis of the main image information is performed,
and composite image information is created by selecting
15 key information corresponding to one of said plurality
of pieces of key information which has a frequency
component having the lowest similarity to the frequency
component of the main image information.

13. An image processing method of recording, on a
20 recording medium in a visible state, composite image
information created by embedding sub-information in
visible main image information in an invisible state,
comprising:

performing first pre-processing of thinning out
25 main image information in correspondence with pixel
formation processing at the time of image recording;
performing second pre-processing including

geometric transformation processing of, after rotating
the main image information through a predetermined
angle, removing a thinned-out portion from the main
image information, compressing an effective portion of
5 the main image information, and reconstructing the main
image information;

performing embedding processing of embedding the
sub-information in the main image information having
undergone the second pre-processing in an invisible
10 state by performing color difference modulation
processing using the main image information, the
sub-information, and key information used to restore
the sub-information, thereby creating composite image
information;

15 performing inverse transformation processing of
performing transformation processing inverse to
transformation processing in the second pre-processing
for the composite image information after expanding and
reconstructing an effective portion of the composite
20 image information by inserting, in the composite image
information, not-to-be-recorded information
corresponding to the thinned-out portion of the main
image information; and

performing recording processing of recording, on a
25 recording medium, the composite image information,
inversely transformed by the inverse transformation
processing, by performing an alternate

driving/recording scheme of alternately recording even-numbered and odd-numbered pixels in a main scanning direction of a recording device on a recording line basis.

5 14. A method according to claim 13, wherein in the first pre-processing, when the main image information is to be thinned out, even-numbered and odd-numbered pixels are alternately thinned out in correspondence with a recording line of a recording device.

10 15. An image processing method of recording, on a recording medium in a visible state, composite image information created by embedding sub-information in visible main image information in an invisible state, comprising:

15 performing first pre-processing of thinning out main image information in correspondence with pixel formation processing at the time of image recording;
 performing second pre-processing including geometric transformation processing of, after rotating
20 the main image information through a predetermined angle, removing a thinned-out portion from the main image information, compressing an effective portion of the main image information, and reconstructing the main image information;

25 performing embedding processing of embedding the sub-information in the main image information in an invisible state by superimposing the main image

information and superimposition information created by performing color difference modulation processing using the sub-information and key information used to restore the sub-information, thereby creating composite image information;

performing inverse transformation processing of performing transformation processing inverse to transformation processing in the second pre-processing for the composite image information after expanding and reconstructing an effective portion of the composite image information by inserting, in the composite image information, not-to-be-recorded information corresponding to the thinned-out portion of the main image information; and

performing recording processing of recording, on a recording medium, the composite image information, inversely transformed by the inverse transformation processing, by performing an alternate driving/recording scheme of alternately recording even-numbered and odd-numbered pixels in a main scanning direction of a recording device on a recording line basis.

16. An image recording apparatus comprising:

an embedding processing section which embeds sub-information in main image information in an invisible state by performing color difference modulation, thereby creating composite image information;

an image processing section which performs pixel formation processing in the image recording apparatus for the composite image information created by the embedding processing section, and performs

5 predetermined image processing in accordance with recording operation; and

a recording section which records the composite image information processed by the image processing section on a recording medium by an alternate
10 driving/recording scheme of alternately forming even-numbered and odd-numbered pixels in a main scanning direction of a recording device on a recording line basis.

17. An image recording apparatus comprising:

15 a first pre-processing section which thins out main image information in correspondence with pixel formation processing in the image recording apparatus;

a second pre-processing section which performs second pre-processing including geometric transformation processing of, after rotating the main image
20 information through a predetermined angle, removing a thinned-out portion from the main image information, compressing an effective portion of the main image information, and reconstructing the main image
25 information;

an embedding processing section which embeds the sub-information in the main image information in an

invisible state by performing color difference modulation processing, thereby creating composite image information;

an inverse transformation processing which
5 performs inverse transformation processing of performing transformation processing inverse to transformation processing in the second pre-processing for the composite image information after expanding and reconstructing an effective portion of the composite
10 image information by inserting, in the composite image information, not-to-be-recorded information corresponding to the thinned-out portion of the main image information; and

a recording section which performs recording
15 processing of recording, on a recording medium, the composite image information, inversely transformed by the inverse transformation processing section, by performing an alternate driving/recording scheme of alternately recording even-numbered and odd-numbered
20 pixels in a main scanning direction of a recording device on a recording line basis.

18. An image recording apparatus comprising:

an embedding processing section which embeds sub-information in main image information in an
25 invisible state by performing color difference modulation, thereby creating composite image information;

an image processing section which doubles the number of pixels of the composite image information created by the embedding processing section in a sub-scanning direction of a recording device, and
5 performing thinning-out processing in correspondence with pixel formation processing in the image recording apparatus; and

a recording section which records the composite image information processed by the image processing
10 section on a recording medium by using an alternate driving/recording scheme of alternately forming odd-numbered and even-numbered pixels in a main scanning direction of the recording device on a recording line basis and conveying the recording medium
15 with a convey pitch $1/2$ a pixel pitch in the main scanning direction.

19. A printed material on which a facial image as a multilevel image, a ghost image as a facial image obtained by reducing a density of the facial image, and
20 a binary image as a character are printed, wherein

the ghost image is printed while binary image data obtained by performing predetermined processing for binary image data associated with an image to be printed on the printed material is embedded in the
25 ghost image.

20. A printed material according claim 19, wherein even-numbered and odd-numbered pixels of a

multilevel image of the facial image, ghost image, and binary image are alternately recorded on a recording line basis by a printer based on a thermal transfer recording scheme of performing thermal transfer recording using a thermal head having a plurality of heating elements arrayed in a line, and

pixels of a binary image of the facial image, ghost image, and binary image are recorded, by a printer based on a thermal transfer recording scheme of performing thermal transfer recording by using a thermal head having a plurality of heating elements arrayed in a line, in a direction in which the heating elements are arrayed.

21. A printed material according to claim 20, wherein the ghost image is printed while binary image data which is obtained by performing predetermined processing for binary image data associated with an image to be printed on the printed material and is inclined at not less than about 26° and not more than 45° with respect to a direction in which the respective pixels are arrayed is embedded in the ghost image.

22. A printed material according to claim 21, wherein the image data printed as the ghost image comprises image data which is obtained by performing quantization processing for each pixel of the image data of the ghost image embedded in the binary image data and performing error diffusion processing for

neighboring pixels of the quantized pixels on the basis of a predetermined range of neighboring pixels to which a quantization error is to be diffused and a diffusion coefficient for each neighboring pixel.

5 23. A printed material according to claim 20, wherein the image data printed as the ghost image comprises image data obtained by quantization processing for each pixel of the image data of the ghost image in which binary image data associated with
10 an image to be printed on the printed material is embedded.

 24. A printing method of printing a facial image as a multilevel image, a ghost image as a facial image obtained by reducing a density of the facial image, and
15 a binary image as a character on a printing medium, wherein

 the image data printed as the ghost image is created by performing predetermined processing for binary image data associated with an image to be
20 printed on the printing medium and embedding the binary image data having undergone the predetermined processing in image data of the ghost image.

 25. A method according to claim 24, wherein even-numbered and odd-numbered pixels of a
25 multilevel image of the facial image, ghost image, and binary image are alternately recorded on a recording line basis by a printer based on a thermal transfer

recording scheme of performing thermal transfer
recording using a thermal head having a plurality of
heating elements arrayed in a line, and

pixels of a binary image of the facial image,
5 ghost image, and binary image are recorded, by a
printer based on a thermal transfer recording scheme of
performing thermal transfer recording by using a
thermal head having a plurality of heating elements
arrayed in a line, in a direction in which the heating
10 elements are arrayed.

26. A method according to claim 25, wherein image
data to be printed as the ghost image is created by
performing predetermined processing for binary image
data associated with an image to be printed on the
15 printing medium, and embedding the binary image data
having undergone the predetermined processing in the
image data of the ghost image at an angle of not less
than about 26° and not more than 45° with respect to a
direction in which the respective pixels are arrayed.

20 27. A method according to claim 25, wherein image
data to be printed as the ghost image is created by
performing predetermined processing for binary image
data associated with an image to be printed on the
printing medium, embedding binary image data having
25 undergone the predetermined processing in the image
data of the ghost image at an angle of not less than
about 26° and not more than 45° with respect to a

direction in which the respective pixels are arrayed,
performing quantization processing for each pixel of
the image data in which the binary image data is
embedded, and performing error diffusion processing for
5 neighboring pixels of the quantized pixels on the basis
of a predetermined range of neighboring pixels to which
a quantization error is to be diffused and a diffusion
coefficient for each neighboring pixel.

28. A method according to claim 25, wherein image
10 data to be printed as the ghost image is created by
embedding binary image data associated with an image to
be printed on the printing medium in image data of the
ghost image, and performing quantization processing for
each pixel of the image data in which the binary image
15 data is embedded.

29. A method according to claim 28, wherein the
quantization processing comprises error diffusion
processing.

30. A method according to claim 28, wherein the
20 quantization processing comprises dither processing.